FINAL REPORT
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Diet Composition and Habitat Segment Selection by Deer and Elk on Clearcut and Uncut Aspen Summer Range in Northern Utah.

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Deer and Elk Diets and Activities on Different Habitat Segments in the Aspen Zone of the Davis County Experimental Watershed

by

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ABSTRACT

The monthly diets of deer (Odocoileus h. hemionus) and elk (Cervus canadensis nelsoni) were estimated on a species dry-weight basis for different habitat segments of the aspen (Populus tremuloides) type. Forbs contributed most to total consumption by both species; however, during times of low forb availability, elk diets shifted to grasses and sedges, and deer shifted to browse.

Deer preferred meadows for grazing, aspen and meadows for resting, and logging roads for travel routes. Elk preferred meadows, logging roads, and clearcuts as foraging sites, but preferred meadows for resting, and logging roads for travel routes. Pellet group distributions were unrepresentative of relative time spent on various habitat segments. Microclimatic factors have strong influence on deer and elk distribution.

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INTRODUCTION AND OBJECTIVES

Introduction

Knowledge of diets and feeding strategies of deer and elk is requisite to the development of silvicultural, grazing, and recreational practices which will affect deer and elk summer range. Excessive buildups of large herbivores, livestock and big game, have been cited as prime factors in vast watershed destruction; this has been clearly documented for watersheds along the Wasatch front in north-central Utah, of which the Davis County Experimental Watershed (DCEW) is a part. Thus, deer and elk must be recognized as integral to any such watershed.

Much of the DCEW is included in the aspen type, which represents important summer range for both deer and elk throughout most of the Intermountain West. These summer ranges can be highly productive in terms of important big game forages. They characteristically represent that phase of the migration cycle where deer and elk rear their young and reestablish body condition for breeding and winter survival. Rejuvenation of mature aspen and maintenance as a seral successional stage with good water yielding properties may also provide, through proper management, increased big game summer range values.

Objectives

1. To determine the biweekly or monthly diet composition of deer and elk on a species-dry-weight basis for various habitat segments within the aspen cover type.

2. To determine forage consumption rates of deer and elk on a species dry-weight basis for various habitat segments within the aspen zone.

3. To determine total forage consumption by deer and elk on each habitat segment.

4. To determine deer and elk habitat segment preferences in the aspen zone.

STUDY AREA

The study was conducted on the Chicken Creek drainage of the Davis County Experimental Watershed in north-central Utah. The aspen type covers more than 60 percent of these watersheds. Five sites, representing about 30 acres, on the west branch of the drainage were clearcut during 1974 to 1976 (Figure 1). Other types--grass-forb, mountain brush, sagebrush-grass, conifer, and wet meadow--are represented to varying degrees, and provided an excellent opportunity to investigate their associated importance to deer and elk use of the aspen type. A detailed description of the study area is given by Johnston and Doty (1972).

METHODS AND PROCEDURES

Several authors (Buechner 1950, Wallmo 1951, McMahan 1961, Longhurst et al. 1968, Neff 1974) have shown that observation of tame animals is a reliable method for determining some aspects of dietary behavior. Consequently, tame deer and elk were observed on selected sites to obtain diet composition and behavior data. The use of tame animals is expensive and requires long-termed investment in raising and training the animals, but it is the best method for meeting the study objectives.

Tame deer and elk available at the Utah Division of Wildlife Resources Green Canyon facility were used for the study. Both species were bottle raised, the deer having been obtained as fawns from captive deer, and the

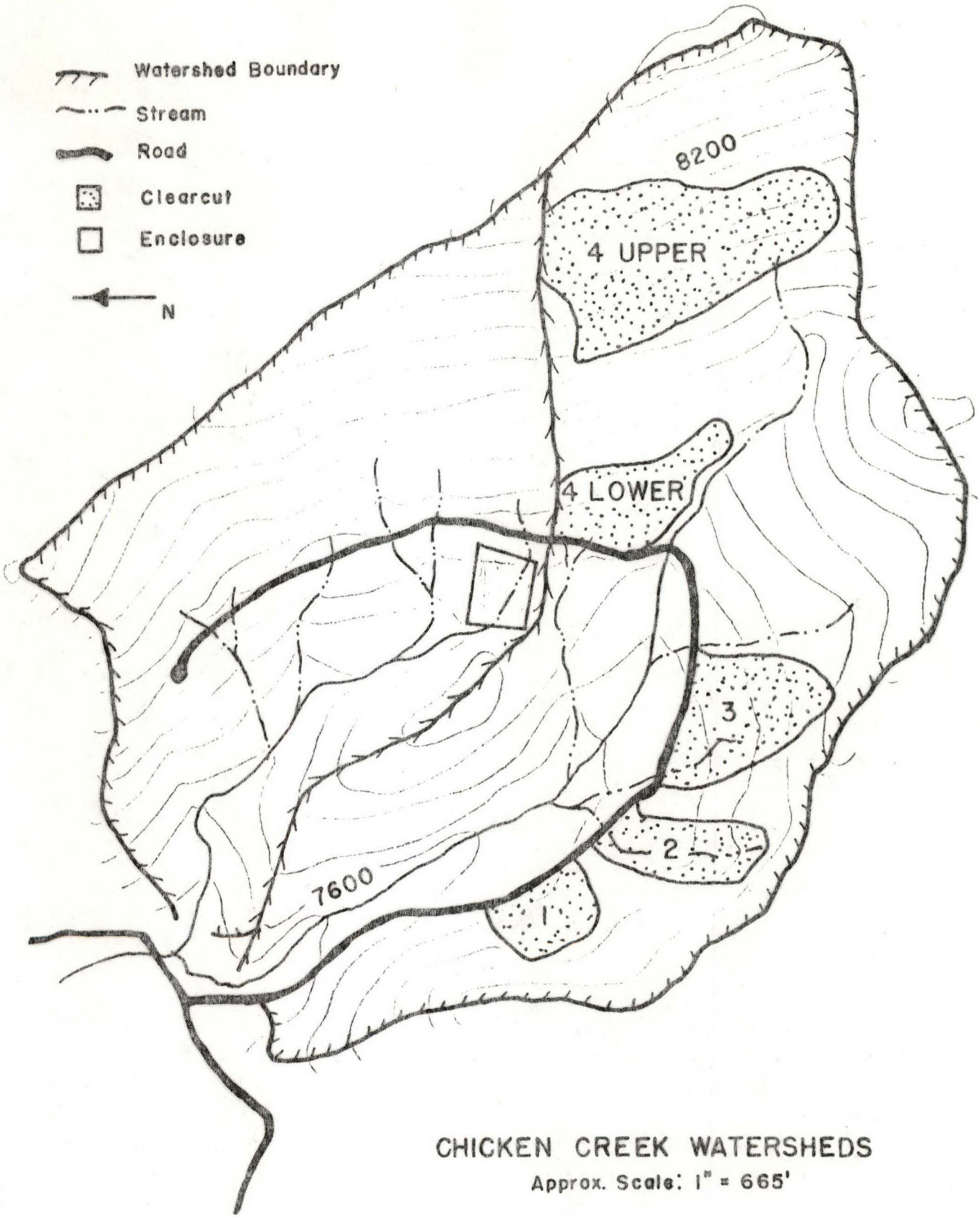

Figure 1. The Chicken Creek Watersheds, Davis County Experimental Watersheds, Utah.

elk as calves from the Hardware Ranch near Logan. Previous studies (Collins 1977, Deschamp 1977, Smith 1976) involving these same animals demonstrated that the animal's food preferences are innate and have not been recognizably influenced by artificial rearing. This is in agreement with research already cited, but some researchers (Arnold 1969, Neff 1974) have suggested that aniamls exhibit unsettled preferences and atypical exploratory behavior when they are maintained on vegetation unlike that being sampled. Thus, an enclosure (approximately 7 acres) was built on the East Branch of the Chicken Creek watershed to enclose vegetation representative of that which was sampled. The animals were taken to the enclosure for a 5-day adjustment period on 10 June 1977 and were kept there throughout the summer when not being used for sampling.

The bite count technique described by Wallmo and Neff (1970) was used to quantify forage consumption on a species-dry-weight basis. Sampling began 16 June 1977. Each habitat segment was sampled one day per week with four elk and three deer (a fourth deer proved untractable for dietary sampling). The fact that attractive foraging areas were not bounded by unattractive areas made it too difficult to obtain precise 0.5 hour samples (as proposed) on each setment, because the animals frequently wandered from segment to segment. Hence, the observer wandered with the animals, recording the number of minutes grazing accumulated on each segment. Thus, samples sizes were not equal, but grazing behavior was more representative of that in natural situations.

Numbers of bites taken of each plant species were counted on a tape recorder to accommodate rapid sampling. Careful note was made of mean bite size and plant part eaten for each dietary species. Later, five bags of 25 simulated bites of each species observed in the diet were collected.

The contents of the bags were then oven-dried and weighed to obtain an estimate of mean bite size for each species. The mean weight was then multiplied by the number of bites each animal took of that species during the sample period. Mean simulated-bite weights were used to transform only the numbers of bites taken in the period in which mean weight was determined.

Once each two-week period, on separate days, all four elk or one deer were released and allowed to roam freely for a 24-hour period. Percent total activity was determined with scan sampling, a behavior-sampling technique described by Altmann (1974). At the end of each 10-minute interval within the 24-hour period, the activity of each animal and its location with reference to habitat segment was noted. The activity time total on each different habitat segment was then taken as a percent of the total specific activity time on all habitat segments combined. These percents were then divided by appropriate percents of each area, thus producing activity-specific preference quotients. The formula is as follows:

$$\text{Habitat Segment Preference} = \frac{\%\text{ of total activity time}}{\%\text{ of total time}}$$

Percent of total area was determined by measuring the amount of area each habitat segment represents of the general area, and the general area was defined as that encompassed by lines connecting the points of furthest animal movement as recorded over the entire summer. Radio collars were attached to one or two animals to aid in finding them when they ran out of sight.

Total consumption on each habitat segment was then estimated by weighting the grazing time (percent of 24-hour period) occurring on

each habitat segment by the consumption rate calculated from diet observation trials.

A record of defecations was kept during the 24-hour periods to check the reliability of pellet counts as indexes to habitat segment preferences. Each defecation was recorded with reference to both the habitat segment in which it was deposited and the animal's activity at the time of defecation. The test for goodness of fit was made of the observed distribution of elk use versus the expected distribution of elk use based on distribution of pellet groups.

In mid-July, after it became apparent that microclimate had a strong influence on animal activity, weather stations were installed in north and south slope aspen stands, meadow bottom, and clearcut #3. These were used to monitor ambient air temperature, relatively humidity, and windspeed at a representative animal height, 2.5 feet above ground. Hygrothermographs in standard weather shelters and totalizing anemometers were used for these purposes; hygrothermograph charts were changed and anemometers read weekly.

RESULTS AND DISCUSSION

Monthly Diets

Deer Diets

During the course of the summer, the deer consumed 79 species, including 62 forbs, 5 grasses and sedges, 10 shrubs and trees, and 2 mushrooms. Of these, 11 forbs and 4 shrubs occurred as principal species (those comprising 5 percent or more) in the diet. Diets are presented by month on a species dry-weight basis in Tables 1 through 4. Monthly summaries by forage class are presented in Figure 2.

Table 1. Diet composition by dry weight of deer grazing aspen meadow.

Plant Species	June	July	August	September	$\bar{X}$
	Percent				
Forbs					
Achillea lanulosa	0.0	0.0	0.1	0.0	+ [a]
Aconitum columbianum	0.3	+	1.4	2.2	0.9
Agastache urticifolia	0.0	0.1	0.0	0.5	0.1
Agoseris glauca	0.0	0.7	0.0	0.0	0.2
Arabis holboellii	0.1	0.0	0.0	0.0	+
Aster chilensis	0.0	0.1	0.8	0.0	0.3
Aster engelmannii	0.0	0.1	0.0	0.0	+
Aster foliaceous	2.2	8.6	7.1	7.2	6.8
Aster integrifolius	0.1	+	0.2	0.0	0.1
Camassia quamash	0.3	0.0	0.0	0.0	0.1
Castillegia spp.	0.0	0.0	1.6	0.0	0.5
Chenopodium fremontii	0.0	0.3	0.5	0.0	0.3
Collomia linearis	2.9	1.6	0.0	0.0	0.3
Delphinium nelsoni	0.2	0.0	0.0	0.0	+
Descurania spp.	0.3	0.1	0.1	0.0	0.1
Epilobium brevistylum	0.0	0.0	27.9	37.2	15.5
Erigeron perigrinus	0.4	0.2	0.0	0.0	0.1
Erythronium grandiflorum	0.2	0.0	0.0	0.0	+
Fragaria americana	0.0	0.1	0.0	0.0	+
Gayophytum nuttallii	2.0	13.2	9.0	1.0	7.9
Geranium fremontii	1.0	1.1	2.0	3.2	1.7

Table 1. Continued

Plant Species	June	July	August	September	$\bar{X}$
	Percent				
Habenaria dilatata	0.0	+	0.0	0.0	+
Hackelia floribunda	+	0.0	0.0	0.0	+
Heraculum lanatum	0.0	0.0	0.3	0.0	0.1
Lactuca scariola	1.3	0.1	0.1	0.9	0.4
Lathyrus lanszwertiii	2.6	5.4	0.0	0.0	1.3
Lepidium virginicum	0.0	0.0	0.0	1.0	+
Madia glomerata	0.0	4.7	1.4	6.1	3.1
Melilotus officinalis	2.9	0.9	1.5	0.1	1.3
Mertensia arizonica	0.1	+	0.0	0.0	+
Mimulus parryi	0.0	0.4	9.2	4.4	3.9
Osmorhiza occidentalis	0.0	+	0.0	0.0	+
Polygonum bistortoides	44.1	23.9	2.0	0.0	16.0
Polygonum douglasi	0.0	+	0.8	0.0	0.3
Potentilla gracillis	0.0	6.3	1.0	0.0	2.4
Rumex crispus	0.5	0.0	0.7	1.3	0.5
Sidalcea neomexicana	0.0	5.1	0.0	0.1	1.7
Stellaria jamesiana	0.0	0.1	0.0	0.0	+
Taraxacum officinale	2.0	0.9	1.9	17.7	4.2
Thalictrum fendleri	0.0	0.0	+	0.0	+
Tragopogon dubius	0.4	1.3	7.8	0.0	3.1
Trifolium sp	0.0	1.5	0.1	1.7	0.8
Valeriana occidentalis	0.0	+	0.7	0.0	0.2
Vicia americana	0.1	4.2	4.2	5.2	3.7

Table 1. Continued

Plant Species	June	July	August	September	$\bar{X}$
	Percent				
Viguiera multiflora	0.0	0.1	0.0	0.0	+
Viola spp.	28.5	7.7	0.1	0.0	7.4
Wyethia amplexicaulis	3.7	7.5	2.9	0.0	4.1
Totals	96.2	96.3	85.4	89.8	89.4
Grasses and Sedges					
Agropyron subsecundum	0.0	0.0	0.3	0.0	0.1
Bromus carinatus	0.0	1.6	+	0.0	0.5
Carex canescens	0.1	0.0	0.0	0.0	+
Phleum alpinum	1.1	0.0	0.0	0.0	0.2
Scirpus microcarpus	+	0.0	0.0	0.0	+
Totals	2.2	1.6	0.3	0.0	0.8
Browse					
Alnus tenuifolia	0.8	0.0	3.6	6.4	2.4
Amelanchier alnifolia	0.0	0.2	0.0	0.0	0.1
Populus tremuloides	1.9	1.2	2.9	1.8	2.0
Rosa woodsiii	0.0	0.0	0.1	0.0	+
Salix spp	1.1	2.1	0.5	0.0	1.1
Sambucus racemosa	0.0	0.0	3.3	0.0	1.1
Symphoricarpos oreophilus	0.0	0.7	1.5	1.6	0.7
Totals	3.8	4.2	11.9	9.8	7.4
Mushroom [b]	0.0	0.0	1.9	0.0	0.6

[a] + = trace item, less than 0.05% of diet.

[b] Mushrooms not identified.

Table 2. Diet composition by dry weight of deer grazing aspen forest.

Plant Species	June	July	August	September	$\bar{X}$
	Percent				
Forbs					
Achillea lanulosa	+[a]	0.0	+	0.0	+
Aconitum columbianum	0.2	0.9	0.0	0.0	0.3
Agastache urticifolia	0.3	1.5	3.4	5.2	2.6
Aquilegia caerulea	3.0	1.3	0.0	0.0	0.9
Aster chilensis	0.0	0.5	0.0	0.0	0.2
Aster engelmanii	0.7	7.1	1.2	2.3	3.3
Aster foliaceous	4.8	19.6	15.1	1.5	12.6
Castillegia spp.	0.9	+	0.0	0.0	0.2
Chenopodium fremontii	0.0	0.0	0.1	0.0	+
Chlorocrambe hastatus	0.4	0.4	0.0	0.7	0.3
Claytonia lanceolata	0.1	0.0	0.0	0.0	+
Collinsia parviflora	0.1	0.0	0.0	0.0	+
Collomia linearis	0.7	0.1	0.1	0.0	0.2
Delphinium nelsoni	1.3	0.1	0.0	0.0	0.3
Descurania spp.	1.2	0.4	0.1	0.0	0.4
Erigeron perigrinus	1.8	0.1	0.0	0.0	0.3
Erysimum inconspicuum	0.1	0.0	0.0	0.0	+
Erythronium grandiflorum	3.4	0.0	0.0	0.0	0.6
Gayophytum nuttallii	0.3	1.7	1.5	+	1.1
Geranium richardsonii	1.1	0.9	0.6	0.7	0.8
Hackelia floribunda	0.6	+	0.0	0.0	0.1
Heraculum lanatum	0.0	0.0	0.7	2.5	0.7

Table 2. Continued

Plant Species	June	July	August	September	$\bar{X}$
	Percent				
Hieracium scouleri	0.3	0.1	0.1	0.0	0.1
Hydrophylum capatatum	1.8	0.0	0.0	0.0	0.3
Lactuca scariola	0.0	0.1	0.0	0.0	+
Lathyrus lanzwertii	27.2	10.3	1.6	5.8	9.5
Mertensia arizonica	1.2	0.0	+	0.0	0.2
Nemophyla breviflora	0.2	0.0	0.0	0.0	+
Osmorhiza chilensis	0.0	0.1	0.0	0.0	+
Osmorhiza occidentalis	1.0	0.1	0.1	+	0.1
Polemonium foliosissimum	0.9	0.0	0.0	0.1	0.2
Polygonum bistortoides	0.2	0.0	0.0	0.0	+
Polygonum douglasi	0.0	0.0	0.3	0.1	0.1
Ranunculus spp.	0.4	0.0	0.0	0.0	0.1
Rudbeckia occidentalis	0.6	0.0	0.0	0.0	0.1
Rumex crispus	0.0	0.1	0.0	0.0	+
Senecio serra	0.2	0.0	0.0	0.0	+
Sidalcea neomexicana	0.0	0.1	+	0.2	0.1
Taraxacum officinale	0.9	0.6	0.3	0.1	0.5
Thalictrum fendleri	0.0	0.6	2.3	1.4	1.2
Tragopogon dubius	0.0	0.2	+	0.0	0.1
Valeriana occidentalis	4.7	14.4	23.2	6.3	14.4
Vicia americana	6.6	19.2	5.9	1.6	9.7
Viola spp.	0.3	1.3	0.0	0.0	0.5
Wyethia amplexicaulis	7.7	0.0	0.0	0.0	1.3
Totals	75.2	81.8	56.6	28.5	63.4

Table 2. Continued

Plant Species	June	July	August	September	$\bar{X}$
	Percent				
Grasses					
Agropyron subsecundum	0.8	+	0.2	+	0.2
Bromus carinatus	1.4	0.0	0.0	0.0	0.2
Totals	2.2	+	0.2	+	0.4
Browse					
Acer grandidentatum	0.1	0.0	0.0	0.0	+
Alnus tenuifolia	0.0	0.1	0.0	0.4	0.1
Amelanchier alnifolia	0.0	3.9	3.0	4.0	3.0
Populus tremuloides	16.9	1.6	4.8	6.5	6.0
Prunus virginiana	1.2	0.1	0.0	0.0	0.3
Quercus gambelii	0.5	0.0	0.0	0.0	0.1
Ribes	1.7	0.0	0.0	1.9	0.6
Rosa woodsii	0.8	1.9	0.4	0.0	0.9
Symphoricarpos oreophilus	0.7	10.1	32.8	58.0	24.1
Totals	21.9	17.7	41.0	70.8	35.1
Mushrooms[b]	0.2	0.5	1.3	0.7	0.8

[a] + = trace item, less than 0.05% of diet.

[b] Mushrooms not identified.

Table 3. Diet composition by dry weight of deer grazing mountain brush.

Plant Species	June	July	August	September	$\bar{X}$
	Percent				
Forbs					
Achillea lanulosa	+[a]	+	0.0	0.0	+
Agastache urticifolia	0.5	2.0	0.0	0.0	0.2
Allium acuminatum	0.1	0.0	0.0	0.0	+
Aquilegia caerulea	0.6	0.0	0.0	0.0	0.1
Arabis holboellii	+	0.0	0.0	0.0	+
Aster chilensis	0.0	+	1.1	0.0	0.4
Aster engelmanii	0.0	0.1	0.0	0.0	+
Aster foliaceous	1.0	4.0	4.1	0.0	2.9
Aster integrifolius	0.1	0.1	0.0	0.0	0.1
Collomia linearis	2.9	0.2	0.0	0.0	0.6
Delphinium nelsoni	+	0.0	0.0	0.0	+
Descurania spp.	0.3	0.1	0.0	0.0	0.1
Erigeron perigrinus	10.0	1.7	0.0	0.0	2.2
Erythronium grandiflorum	0.3	0.0	0.0	0.0	0.1
Gayophytum nuttallii	0.7	13.0	6.1	0.4	6.6
Geranium fremontii	8.6	1.2	3.6	0.0	3.0
Hackelia floribunda	+	0.0	0.0	0.0	+
Hieracium scouleri	1.1	0.9	0.7	0.4	0.8
Lactuca scariola	0.0	0.4	0.0	0.0	0.1
Lathyrus lanzwertii	15.2	13.3	1.5	0.0	7.5
Lepidium virginicum	0.0	0.1	0.0	0.0	+
Madia glomerata	0.3	1.3	0.6	0.0	0.7
Mertensia arizonica	+	0.0	0.0	0.0	+

Table 3. Continued

Plant Species	June	July	August	September	$\bar{X}$
	Percent				
Penstemon	+	0.0	0.0	0.0	+
Phacelia heterophylla	0.3	0.0	0.0	0.0	0.1
Polygonum douglasi	0.0	0.0	0.2	0.0	0.1
Sidalcea neomexicana	0.2	1.3	0.0	0.0	0.5
Tragopogon dubius	0.0	5.8	1.1	0.0	2.3
Valeriana occidentalis	0.2	0.0	0.0	0.0	+
Vicia americana	3.5	6.0	2.6	0.0	3.5
Viola spp.	13.8	4.0	4.0	0.0	5.0
Wyethia amplexicaulis	5.4	1.2	1.3	0.0	1.7
Totals	64.9	56.7	26.9	0.8	38.6
Grasses					
Agropyron subsecundum	0.9	+	0.0	0.0	0.2
Bromus carinatus	0.6	+	0.0	0.0	0.1
Totals	1.5	+	0.0	0.0	0.3
Browse					
Amelanchier alnifolia	0.0	15.7	0.0	0.0	5.2
Populus tremuloides	5.6	0.1	0.8	0.0	1.2
Prunus virginiana	0.4	0.0	0.4	0.0	0.2
Quercus gambelii	0.4	+	+	0.0	0.1
Rosa woodsii	24.8	3.1	0.1	0.0	5.2
Symphoricarpos oreophilus	1.8	24.2	73.5	98.8	49.3
Totals	33.0	43.1	74.8	98.8	61.2
Mushrooms[b]	0.0	0.0	0.0	0.4	0.1

[a] + = trace item, less than 0.05% of diet.
[b] Mushrooms not identified.

Table 4. Diet composition by dry weight of deer grazing clearcut aspen.

Plant Species	June	July	August	September	$\bar{X}$
	Percent				
Forbs					
Acconitum columbianum	0.1	0.3	0.3	0.0	0.2
Agastache urticifolia	0.6	1.5	6.4	11.9	6.7
Aquilegia caerulea	0.4	4.5	4.7	6.8	4.3
Aster engelmanii	0.9	3.3	0.0	0.0	1.3
Aster foliaceous	7.6	0.2	0.2	0.0	1.4
Castillegia spp.	0.5	0.0	0.0	0.0	0.1
Chenopodium fremontii	0.0	0.0	2.5	3.9	1.5
Chlorocrambe hastatus	0.0	4.5	2.8	0.0	2.4
Collomia linearis	0.0	0.3	0.0	0.8	0.2
Delphinium nelsoni	9.8	0.0	0.0	0.0	1.6
Descurania spp.	0.3	0.7	0.4	0.0	0.4
Erigeron perigrinus	3.5	2.5	0.0	0.0	1.4
Erysimum inconspicuum	0.7	0.0	0.0	0.0	0.1
Erythronium grandiflorum	2.1	0.0	0.0	0.0	0.3
Geranium nelsoni	2.7	0.7	0.1	0.0	0.7
Heraculum lanatum	0.0	0.0	10.1	27.4	7.9
Hydrophyllum capitatum	0.4	0.0	0.0	0.0	0.1
Lactuca scariola	0.0	0.0	+	2.2	0.4
Lathyrus lanzwertii	27.8	1.6	2.2	1.7	6.2
Lomatium spp.	0.1	0.0	0.0	0.0	+
Madia glomerata	2.1	0.0	0.0	0.0	0.4
Osmorhiza occidentalis	0.6	0.9	0.0	0.0	0.4
Phacelia heterophylla	0.3	0.0	0.0	0.0	0.1

Table 4. Continued

Plant Species	June	July	August	September	$\bar{X}$
	Percent				
Polemonium foliosissimum	*0.0*	*4.2*	*0.0*	*0.0*	*1.4*
Polygonum douglasi	*0.0*	*0.0*	*2.4*	*3.6*	*1.4*
Taraxacum officinale	*0.8*	*1.7*	*0.0*	*0.0*	*0.7*
Valeriana occidentalis	*6.8*	*8.6*	*10.8*	*21.5*	*11.2*
Vicia americana	*3.1*	*10.9*	*2.4*	*0.0*	*5.0*
Viola spp.	*0.0*	*3.4*	*0.0*	*0.0*	*1.1*
Wyethia amplexicaulis	*3.9*	*0.0*	*0.0*	*0.0*	*0.7*
Totals	75.1	49.8	45.3	79.8	59.6
Browse					
Populus tremuloides	*11.8*	*6.5*	*6.0*	*3.0*	*6.6*
Rosa woodsii	*5.2*	*4.3*	*1.3*	*0.0*	*2.7*
Salix spp.	*6.6*	*1.2*	*2.2*	*0.0*	*2.2*
Symphoricarpos oreophilus	*1.4*	*38.1*	*45.2*	*17.3*	*30.9*
Totals	25.0	50.1	54.7	20.3	42.4

[a] + = trace item, less than 0.05% of diet.

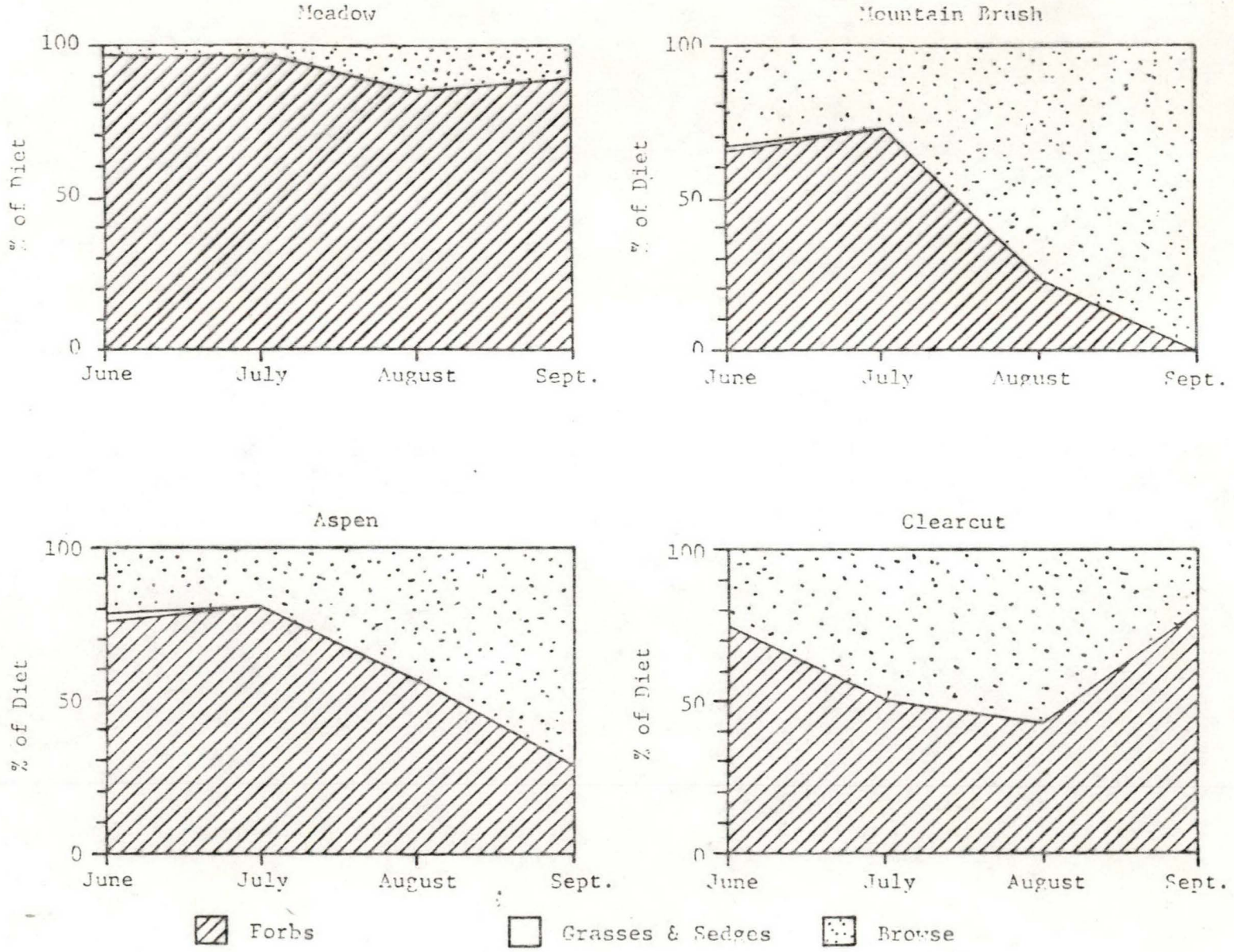

Figure 2. Deer diets by forage class on four habitat segments in the aspen ecosystem, Davis County Experimental Watershed, Utah. Percentages are on a dry-weight basis.

Diets will not be integrated with forage production data to form preference quotients in this report. However, strikingly obvious differences between relative availability and amount consumed of some species allows certain statements on deer food preferences. Among the principal dietary species, the deer appeared to have definite preference for serviceberry (Amelanchier alnifolia), leafybract aster (Aster foliaceous), sierra willowherb (Epilobium brevistylum), American bistort (Polygonum bistortoides), woods rose (Rosa woodsii), American vetch (Vicia americana), violet (Viola sp.), and common valerian (Valeriana occidentalis). Patches of sierra willowherb and American bistort often were almost entirely consumed during initial encounters by the deer. Although highly abundant, butterweed groundsel (Senecio serra), and western coneflower (Rudbeckia occidentalis) were almost totally rejected, and lupine (Lupinus sp.), Arizona bluebells (Mertensia arizonica), chokecherry (Prunus virginiana), and California falsehellebore (Veratrum californicum) were never consumed. Only a few grass species were utilized, and these only slightly, in their earliest stages of growth; most grasses and sedges were completely rejected throughout the summer.

Elk Diets

The elk consumed 81 species, including 57 forbs, 12 grasses and sedges, 10 shrubs and trees, and 2 mushrooms. Of these, 9 forbs, 2 grasses, and 1 shrub occurred as principal dietary species. Monthly diets by habitat segment are presented in Tables 5 through 9, and summaries of forage class in Figure 3.

Of the principal species, the elk appeared to strongly prefer bearded wheatgrass (Agropyron subsecundum), Engelmann aster (Aster engelmannii), leafybract aster, fringed brome (Bromus carinatus), Fremont

Table 5. Diet composition by dry weight of elk grazing aspen meadow.

Plant Species	June	July	August	September	$\bar{X}$
	Percent				
Forbs					
Achillea lanulosa	+[a]	0.0	+	+	+
Aconitum columbianum	0.0	0.0	0.1	0.0	+
Allium acuminatum	+	0.0	0.0	0.0	+
Aster chilensis	0.0	0.0	0.2	0.2	0.1
Aster engelmannii	0.0	0.0	+	0.0	+
Aster foliaceous	15.9	26.7	14.3	13.9	18.6
Aster integrifolius	0.0	0.2	0.7	0.0	0.3
Camassia quamish	+	0.0	0.0	0.0	+
Castillegia spp.	0.0	0.0	0.0	+	+
Chenopodium fremontii	+	0.0	0.9	0.0	0.3
Collomia linearis	0.0	+	+	0.0	+
Delphinium nelsoni	0.0	+	0.0	0.0	+
Epilobium brevistylum	0.0	0.0	2.0	1.3	0.9
Erigeron perigrinus	0.2	0.2	+	0.0	0.1
Erysimum inconspicuum	+	0.0	0.0	0.0	+
Erythronium grandiflorum	+	0.0	0.0	0.0	+
Gayophytum nuttallii	+	0.1	0.5	0.3	0.3
Geranium fremontii	0.5	0.6	0.7	0.0	0.5
Hackelia floribunda	0.1	0.0	0.0	0.0	+
Heraculum lanatum	0.0	2.8	18.8	12.9	9.4
Hieracium scouleri	0.1	0.0	0.0	0.0	+
Hydrophyllum capitatum	+	0.0	0.0	0.0	+
Lactuca scariola	0.0	0.9	1.1	0.0	0.7

Table 5. Continued

Plant Species	June	July	August	September	$\bar{X}$
	Percent				
Lepidium virginicum	0.0	0.0	0.0	+	+
Madia glomerata	0.2	0.4	0.3	0.5	0.4
Mertensia arizonica	2.8	0.0	0.1	0.0	0.5
Mimulus parryi	0.0	0.0	0.8	+	0.3
Polygonum bistortoides	40.0	40.7	5.7	0.0	21.2
Polygonum douglasi	0.0	0.0	0.3	0.6	0.2
Potentilla gracillis	0.2	3.0	0.4	+	1.2
Ranunculus spp.	0.0	+	0.0	+	+
Rudbeckia occidentalis	0.0	+	+	0.0	+
Rumex crispus	0.0	+	0.1	0.0	+
Senecio integrimus	0.0	+	0.0	0.0	+
Sidalcea neomexicana	0.0	0.3	+	0.2	0.1
Taraxacum officinale	0.1	2.8	0.6	0.0	1.2
Thalictrum fendleri	0.0	0.5	2.7	6.6	2.2
Tragopogon dubius	0.0	0.5	0.1	0.0	0.2
Trifolium spp.	0.0	0.3	+	0.0	0.1
Vicia americana	0.0	0.3	0.8	1.1	0.6
Viguiera multiflora	0.0	0.1	+	0.0	+
Viola spp.	1.9	2.0	+	1.1	1.2
Wyethia amplexicaulis	0.3	+	0.0	0.0	0.1
Totals	62.3	82.4	51.2	38.7	60.7
Grasses and Sedges					
Agropyron subsecundum	30.5	1.3	14.0	2.4	10.6
Agrostis exarata	0.0	0.0	2.8	+	0.9
Agrostis stolonifera	0.0	0.1	0.2	14.4	2.5

Table 5. Continued

Plant Species	June	July	August	September	$\bar{X}$
	Percent				
Bromus carinatus	*4.6*	*7.0*	*16.7*	*24.6*	*12.8*
Carex canescens	*0.5*	*1.1*	*3.0*	*0.0*	*1.5*
Juncus ensifolius	*0.0*	*2.5*	*0.5*	*1.2*	*1.2*
Juncus confusus	*0.0*	*+*	*0.3*	*0.0*	*0.1*
Phleum alpinum	*0.0*	*3.6*	*3.3*	*7.5*	*3.6*
Scirpus microcarpus	*0.0*	*+*	*0.5*	*0.0*	*0.2*
Totals	35.6	15.6	41.3	50.1	33.4
Browse					
Alnus tenuifolia	*0.0*	*0.2*	*1.0*	*2.7*	*0.7*
Lonicera involucrata	*0.0*	*+*	*+*	*0.0*	*+*
Populus tremuloides	*0.2*	*0.4*	*0.1*	*0.1*	*0.2*
Prunus virginiana	*0.2*	*0.0*	*0.0*	*0.0*	*+*
Salix spp.	*0.0*	*0.7*	*0.7*	*0.4*	*0.5*
Symphoricarpos oreophilus	*+*	*0.1*	*2.4*	*2.5*	*1.3*
Totals	0.4	1.4	4.2	5.7	2.7
Mushrooms[b]	0.0	0.1	0.3	0.0	0.1
Equisetum arvense	+	+	+	0.0	+

[a] + = trace item, less than 0.05% of diet.
[b] Mushrooms not identified.

Table 6. Diet composition by dry weight of elk grazing aspen forest.

Plant Species	June	July	August	September	$\bar{X}$
	Percent				
Forbs					
Aconitum columbianum	0.1	1.1	0.0	0.0	0.4
Agastache urticifolia	+[a]	0.0	0.0	0.0	+
Agoseris glauca	0.0	0.0	0.1	+	+
Aster foliaceous	5.8	32.5	6.4	8.6	15.4
Aster engelmannii	2.2	3.8	5.8	0.1	5.0
Aster integrifolius	0.0	0.0	0.4	0.0	0.1
Chenopodium fremontii	0.0	+	0.0	0.0	+
Collomia linearis	+	0.1	0.0	0.0	+
Delphinium nelsoni	+	0.0	0.0	0.0	+
Descurania spp.	+	0.0	0.0	0.2	+
Erigeron perigrinus	9.3	1.6	0.9	0.0	2.4
Erythronium grandiflorum	+	0.0	0.0	0.0	+
Gayophytum nuttallii	0.0	1.1	0.1	0.0	0.4
Geranium richardsonii	1.1	3.7	0.9	0.0	1.7
Habenaria dilatata	0.0	+	+	0.0	+
Hackelia floribunda	2.5	0.1	0.7	0.0	0.7
Heraculum lanatum	0.0	16.8	1.2	0.0	6.0
Hydrophyllum capitatum	+	0.0	0.0	0.0	+
Lactuca scariola	0.0	1.4	0.0	0.2	0.5
Lathyrus lanzwertii	0.1	2.6	5.0	13.9	4.9
Lepidium virginicum	0.0	0.1	0.0	0.0	+
Madia glomerata	0.0	0.3	0.0	0.0	0.1
Mertensia arizonica	12.7	0.0	3.9	0.0	3.4

Table 6. Continued

Plant Species	June	July	August	September	$\bar{X}$
	Percent				
Osmorhiza chilensis	0.0	0.1	0.0	0.0	+
Osmorhiza occidentalis	3.5	1.2	1.4	0.0	1.1
Phacelia heterophylla	3.5	1.2	1.4	0.0	1.5
Polemonium foliosissimum	0.0	+	0.0	0.0	+
Polygonum bistortoides	0.0	0.0	0.0	0.4	0.1
Polygonum douglasi	0.0	0.1	+	0.1	0.1
Rudbeckia occidentalis	+	0.0	0.0	0.0	+
Senecio serra	+	0.0	0.0	0.0	+
Sidalcea neomexicana	0.0	0.2	0.0	0.0	0.1
Stellaria jamesiana	0.1	0.0	0.0	0.0	+
Taraxacum officinale	0.6	2.3	0.1	0.0	0.9
Thalictrum fendleri	+	5.0	10.2	7.1	6.3
Tragopogon dubius	0.0	0.1	0.1	0.0	0.1
Valeriana occidentalis	+	0.2	2.0	1.4	1.0
Vicia americana	0.0	4.3	7.5	0.3	4.0
Viguiera multiflora	0.0	+	0.0	0.0	+
Viola spp.	0.5	3.7	0.0	0.0	1.3
Totals	40.0	83.6	48.1	32.3	57.5
Grasses and Sedges					
Agropyron subsecundum	34.2	6.8	3.5	30.8	14.3
Bromus carinatus	16.6	4.1	0.8	5.2	5.3
Poa reflexa	0.4	0.0	0.0	0.0	0.1
Poa spp.	0.2	0.0	0.0	0.0	+
Totals	51.4	10.9	4.3	36.0	19.7
Browse					
Populus tremuloides	9.6	2.4	4.0	0.9	3.9

Table 6. Continued

Plant Species	June	July	August	September	$\bar{X}$
			Percent		
Symphoricarpos oreophilus	*0.4*	*1.7*	*44.5*	*29.6*	*20.4*
Totals	10.4	4.1	48.5	31.5	24.3
Mushrooms[b]	+	2.6	0.6	0.0	1.1

[a] + = trace item, less than 0.05% of diet.

[b] Mushrooms not identified.

Table 7. Diet composition by dry weight of elk grazing clearcut aspen.

Plant Species	June	July	August	September	$\bar{X}$
	Percent				
Forbs					
Aconitum columbianum	0.0	1.5	+[a]	0.1	0.5
Agastache urticifolia	0.0	+	0.0	0.0	+
Aquilegia caerulea	0.0	0.1	0.0	0.0	+
Aster chilensis	0.0	0.0	0.0	0.1	+
Aster engelmannii	0.0	13.8	1.9	0.0	5.2
Aster foliaceous	12.6	29.6	+	10.9	13.8
Chenopodium fremontii	0.0	2.5	3.3	0.3	2.0
Collomia linearis	0.0	0.1	0.0	0.0	+
Erigeron perigrinus	0.0	2.7	0.0	0.0	0.9
Fragaria americana	0.1	0.0	0.0	0.0	+
Gayophytum nuttallii	0.0	+	+	0.0	+
Geranium richardsonii	0.0	2.5	0.0	0.0	0.8
Hackelia floribunda	0.0	0.2	0.0	0.2	0.1
Heraculum lanatum	0.0	8.0	19.1	5.0	9.9
Lactuca scariola	0.0	0.6	0.7	4.2	1.1
Lathyrus lanzwertii	0.0	2.2	0.5	1.3	1.1
Madia glomerata	0.0	0.7	0.0	0.0	0.2
Mertensia arizonica	31.8	0.0	0.0	0.4	5.4
Osmorhiza occidentalis	+	0.4	0.0	0.0	0.1
Polemonium foliosissimum	0.0	0.0	0.0	0.1	+
Polygonum douglasi	0.0	0.5	0.1	0.8	0.3
Taraxacum officinale	11.8	3.1	0.0	0.0	3.0
Thalictrum fendleri	0.0	1.3	8.4	1.7	3.5

Table 7. Continued

Plant Species	June	July	August	September	$\bar{X}$
	Percent				
Tragopogon dubius	0.0	1.9	0.0	0.0	0.6
Valeriana occidentalis	0.0	1.5	6.9	0.1	2.8
Vicia americana	0.0	0.4	1.2	0.2	0.6
Viguiera multiflora	0.5	0.0	0.0	0.0	0.1
Viola spp.	6.3	0.2	0.0	0.0	1.1
Totals	63.1	73.8	42.1	25.4	52.1
Grasses and Sedges					
Agropyron subsecundum	19.1	15.9	4.9	12.5	12.2
Agrostis exarata	0.0	0.0	+	5.6	0.9
Bromus carinatus	10.1	4.0	50.6	56.2	29.3
Carex canescen	0.0	1.4	0.0	0.0	0.5
Totals	29.2	21.3	55.5	74.3	42.9
Browse					
Populus tremuloides	1.0	0.3	1.0	0.5	0.7
Prunus virginiana	0.0	0.2	0.0	0.0	0.1
Ribes	0.0	+	0.0	0.0	+
Rosa woodsii	0.0	0.4	0.0	0.0	0.1
Salix spp.	6.7	3.4	0.0	0.0	2.3
Symphoricarpos oreophilus	0.0	0.2	1.3	0.0	0.5
Totals	7.7	4.5	2.3	0.5	3.7
Mushrooms[b]	0.0	0.2	0.0	0.0	+

[a] + = trace item, less than 0.05% of diet.
[b] Mushrooms not identified.

Table 8. Diet composition by dry weight of elk grazing mountain brush.

Plant Species	June	July	August	September	$\bar{X}$
	Percent				
Forbs					
Agastache urticifolia	0.0	0.1	0.0	0.0	+ [a]
Agoseris glauca	0.0	0.0	0.0	0.1	+
Allium acuminatum	+	0.0	0.0	0.0	+
Aster chilensis	0.0	0.0	1.1	0.1	0.4
Aster engelmannii	0.0	3.8	0.5	0.0	1.4
Aster foliaceous	1.7	14.2	1.4	1.1	5.7
Aster integrifolius	0.0	1.5	1.9	0.4	1.2
Erigeron perigrinus	0.7	10.5	0.7	0.0	3.9
Gayophytum nuttallii	0.0	0.6	0.9	0.2	0.5
Geranium fremontii	3.8	15.1	4.2	0.0	7.1
Hieracium scouleri	+	+	0.4	0.0	0.1
Lactuca scariola	0.0	1.8	1.1	0.1	1.0
Lathyrus lanzwertii	0.0	0.1	1.2	0.2	0.5
Lepidium virginicum	0.0	0.1	+	0.0	+
Madia glomerata	0.0	0.0	1.3	0.5	0.5
Mertensia arizonica	+	3.0	1.9	0.0	1.6
Polygonum douglasi	0.0	+	0.3	0.0	0.1
Senecio integrimus	+	0.0	0.0	0.0	+
Sidalcea neomexicana	0.0	1.0	0.1	+	0.4
Stellaria jamesiana	+	0.0	0.0	0.0	+
Taraxacum officinale	0.3	3.6	0.0	0.0	1.3
Tragopogon dubius	0.0	0.0	0.2	0.0	0.1
Vicia americana	+	6.2	+	0.0	2.1

Table 8. Continued

Plant Species	June	July	August	September	$\bar{X}$
	Percent				
Viguiera multiflora	0.0	0.0	0.2	0.0	0.1
Viola spp.	6.0	16.1	0.1	0.1	6.4
Wyethia amplexicaulis	0.0	0.5	+	0.3	0.2
Totals	12.5	78.2	17.5	3.1	34.6
Grasses and Sedges					
Agropyron subsecundum	82.5	11.7	6.9	4.6	20.7
Bromus carinatus	2.3	2.7	2.8	14.8	4.7
Carex spp.	0.0	+	0.0	0.0	+
Totals	84.8	14.4	9.7	19.4	25.4
Browse					
Populus tremuloides	2.6	2.2	0.2	0.0	1.2
Quercus gambelii	0.0	1.1	+	0.0	0.4
Rosa woodsii	0.0	+	0.0	0.0	+
Symphoricarpos oreophilus	0.0	3.2	71.5	76.5	37.7
Totals	2.6	6.5	71.7	76.5	39.3
Mushrooms[b]	0.0	0.1	0.3	0.0	0.1

[a]+ = trace item, less than 0.05% of diet.
[b]Mushrooms not identified.

Table 9. Continued

Plant Species	June	July	August	September	$\bar{X}$
	Percent				
Grasses					
Agropyron subsecundum	12.9	1.6	6.6	9.5	6.5
Bromus carinatus	0.4	0.4	0.0	20.9	3.7
Totals	13.3	2.0	6.6	30.4	10.2
Browse					
Populus tremuloides	0.0	0.7	0.0	0.0	0.2

[a] + = trace item, less than 0.05% of diet.

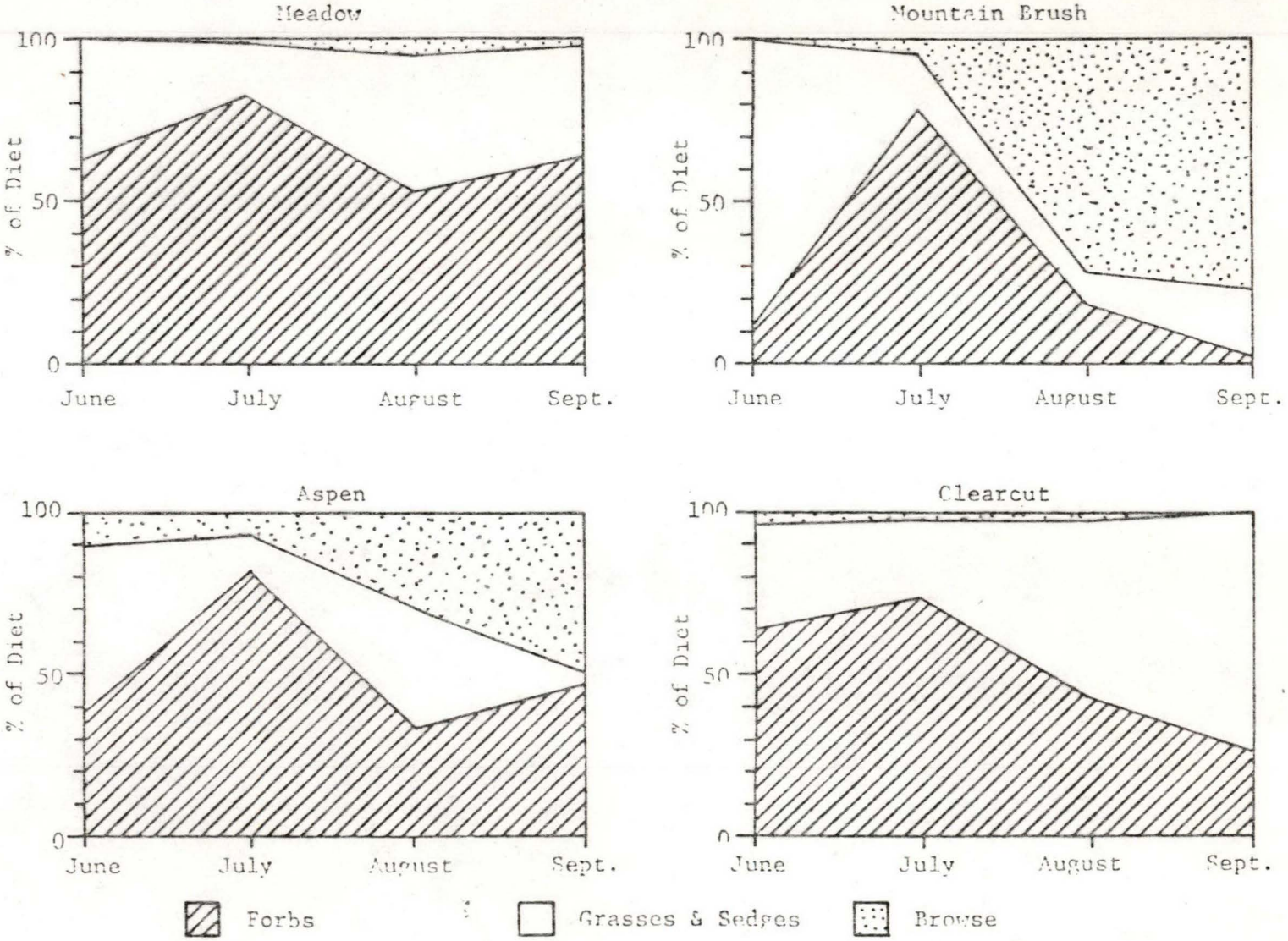

Figure 3. Elk diets by forage class on four habitat segments in the aspen ecosystem, Davis County Experimental Watershed, Utah. Percentages are on a dry-weight basis.

geranium (Geranium fremontii), common cowparsnip (Heracleum lanatum), American bistort, dandelion (Taraxacum officinale), and fendler meadowrue (Thalictrum fendleri). American bistort, and dandelion were definite "ice cream" species with the elk. Common cowparsnip was also highly preferred, but not prior to flowering. Unlike the deer, the elk made considerable use of the grasses in all habitat segments. The importance of this forage resource to elk was especially noticable prior to and after peak forb production.

General Relationships

Considering all factors, forbs appear to be the most important forage class in both deer and elk summer diets. In all habitat segments, forbs were relatively more abundant in the diets than in the forage, and as later discussion will show, the animals preferred that habitat segment where forbs were the major portion of the diet (i.e., meadows). For both deer and elk, peak forb consumption coincided with peak forb production in July.

Browse generally increased in dietary importance after forb availability declined. However, with elk, grasses appeared to be more preferrred than browse as an alternate foor source to forbs.

Forage Consumption

Figure 4 depicts the relative importance of each habitat segment to deer and elk in terms of percent total forage consumed. The aspen segment was roughly three times more important to deer than elk, whereas, the meadow contributed relatively twice as much to the elk than to the deer.

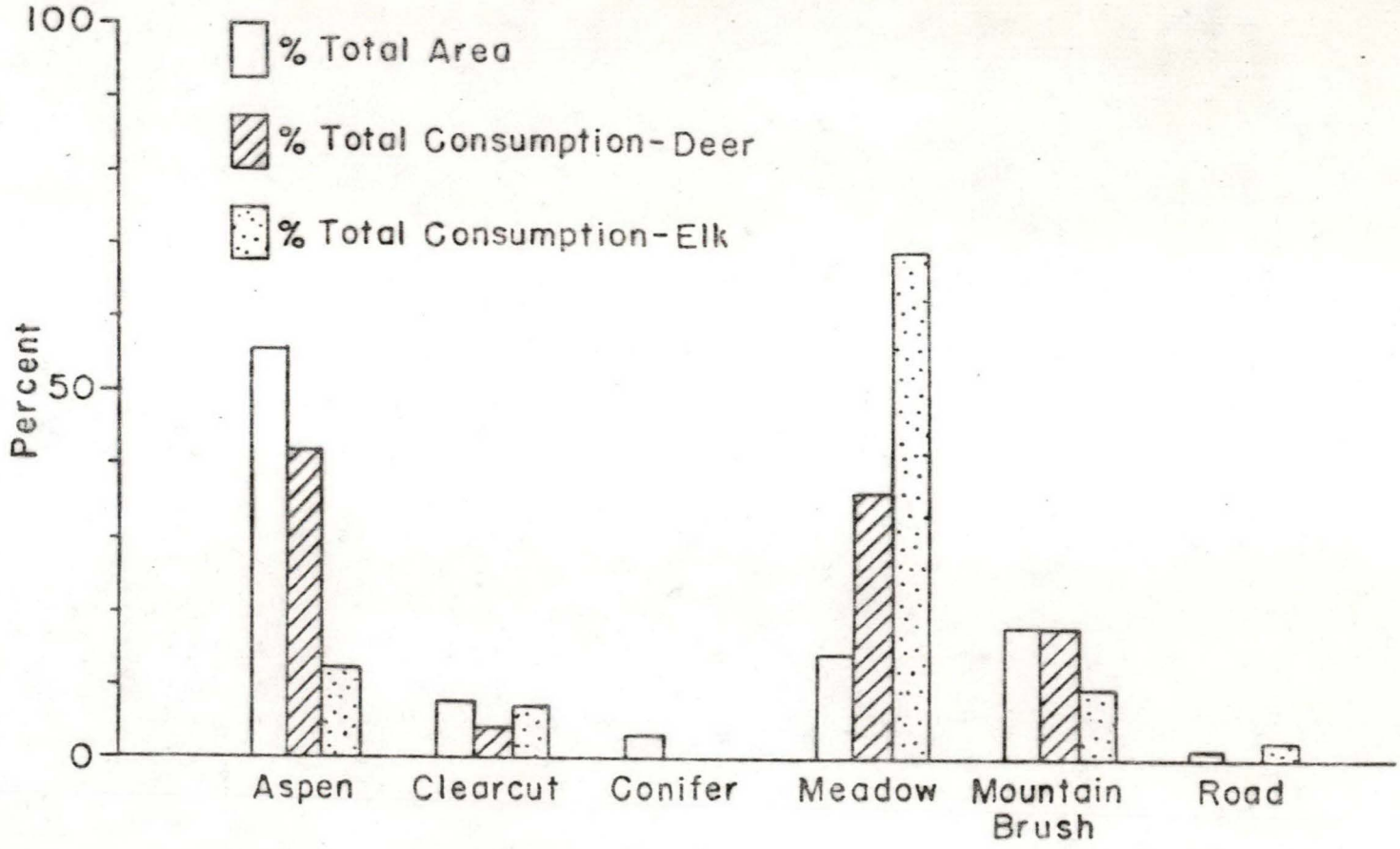

Figure 4. Total forage consumption by deer and elk relative to available area of each habitat segment.

Table 10 presents, by habitat segment, summer mean consumption rates, grazing time, and total consumption. On an average, the elk grazed for about 9.0 hours per day for about 8.5 kg per animal, whereas, the deer grazed 9.6 hours for about 1.5 kg per animal.

Habitat Segment Preferences

Seven 24-hour scan-sampling periods, distributed biweekly throughout the summer, were completed for the deer. However, only five 24-hour periods were completed for the elk, because during the horse-fly season (approximately June 21 to July 21) the elk attempted to migrate out of the area before the periods could be completed.

Table 11 relates voluntary deer and elk use of different habitat segments to the relative available area of each segment. Preference quotients are used to interpret the evident nonrandom use of the area. However, caution should be taken in the interpretation of such quotients, because failure of an animal to "select for" a given environmental factor does not necessarily indicate the factor is unimportant, rather, that it is present in excess of what is needed.

The preference quotients indicate deer selected for meadows, whereas elk selected for meadows, logging roads, and clearcuts (clearcuts only marginally so) as forage sources. The conifer type was totally rejected by both deer and elk in this regard, probably as a result of its extremely low forage productivity. The high productivity and species diversity of the meadow community probably is what stimulates high deer and elk preference for meadows as grazing areas. Most grazing in meadows, however, occurred within 50 m of cover, especially in close proximity to cover along stream channels; little grazing occurred in the center portions of large meadows. Meadows near ridgetops received little grazing

Table 10. Mean summer consumption rates, grazing time, and total consumption by deer and elk on different habitat segments in the aspen type.

Habitat Segment	Deer			Elk		
	Consumption Rate (g/min)	Minutes Grazing / day	Consumption (g/day)	Consumption Rate (g/min)	Minutes Grazing / day	Consumption (g/day)
Aspen	2.6	249	647	10.7	99	1059
Clearcut	2.2	27	59	13.0	46	598
Conifer	0.0	0	0	0.0	0	0
Meadow	2.6	216	562	17.6	334	5878
Mountain Brush	3.3	84	277	15.9	49	779
Road (logging)	0.0	0	0	16.2	14	227

Table 11. Comparative voluntary use of different habitat segments in the aspen ecosystem, Davis County Experimental Watershed, Utah.

Habitat Segment	% Total Area	Grazing				Resting and Other Activities[b]			
		% Total		Preference Quotient[a]		% Total		Preference Quotient	
		Deer	Elk	Deer	Elk	Deer	Elk	Deer	Elk
Aspen	56	43.3	18.3	0.8	0.3	68.0	26.7	1.2	0.5
Clearcut	8	4.8	8.4	0.6	1.1	1.3	3.5	0.2	0.4
Conifer	3	0.0	0.0	0.0	0.0	0.2	1.5	0.1	0.5
Meadow	14	37.5	61.8	2.7	4.4	27.6	64.8	2.0	4.6
Mountain Brush	18	14.4	8.9	0.8	0.5	1.9	1.9	0.1	0.1
Logging Road	1	0.0	2.6	0.0	2.6	2.1	1.5	2.1	1.5

[a]Preference quotient less than 1.0 indicates the segment was selected against, greater than or equal to 1.0 indicates the segment was selected for.
[b]Other activities include traveling, grooming, standing, drinking.

use by either species. Only clearcuts 1, 2, and 3 (Figure 1) were ever voluntarily used by either species. Table 11 indicates that clearcuts were less preferred for grazing by elk than adjacent uncut aspen stands.

Deer preferred aspen, meadow and road segments for resting and other activities, whereas, elk preferred only meadows and roads. Deer used roads only as travel routes, but elk consumed considerable forage there in addition. Elk forage consumption (Table 9) on roads seemed to be stimulated by dandelions which occur there in relatively great abundance. Resting in meadows always occurred in the cover of aspen clones or riparian shrub vegetation associated with streams coursing the area. Classification of these tree areas within the meadows was based on understory composition: understory in such clones is definitely meadow type, hence the classification as meadow. The close association of these clones with a preferred grazing segment probably accounts for their high use as resting sites.

Care should be taken in transferring these preference quotients to wild populations. The animals used in this study behave like their wild counterparts in all ways except for their response to humans. The study animals have been habituated to human activity, hence, they may not have learned aversion to topographic "bottoms" where much human activity normally occurs. However, closure of the Chicken Creek watershed to the public may have masked any study-animal aversion; several wild deer were often seen frequenting bottoms in the Chicken Creek drainages, throughout the summer. Likewise, wild elk have been shown to have high preference for bottoms and associated forage resources (Black, Scherzinger, and Thomas 1976, Pedersen 1976, Lonner 1976). It should also be realized that that these habitat-segment preferences do not reflect any degree of interference competition with livestock.

Microclimatic Factors

At times, microclimatic conditions seemed to directly or indirectly alter deer and elk behavior. During times of high ambient air temperature and net radiation, animal activity seemed to be closely associated with areas of good thermal cover. Increased activity of molesting horseflies (Hybomitra opaca) at high temperatures appeared to be an important indirect effect of microclimate on animal habitat selection. These flies place a heavy stress on both deer and elk, especially elk, and may at times cause the animals to abandon preferred resting and feeding schedules and sites. Lack of thermal cover on clearcuts may be responsible for decreased use of those areas as resting sites; clearcuts do not appear to have a lack of escape cover which would limit their use in this regard (Edgerton and McConnell 1976). Further study will be necessary to discover what the exact relationship of high temperatures is to deer and elk habitat selection in the Chicken Creek area.

Defecations

The distributions of pellet groups relative to actual distributions of deer and elk activity are presented in Table 12. The hypotheses that relative distributions of pellet groups and actual animal use are not significantly different in the aspen type was rejected for both deer and elk. The animals defecated at lowest rates while feeeding in areas of greatest forage abundance (i.e., meadows) and least animal movement (Collins 1977).

Table 12. Distribution of pellet groups, grazing, and all activities combined for both deer and elk in the aspen type, Davis County Experimental Watershed, Utah.

Habitat Segment	Distribution of Pellet Groups (% of Total)		Distribution of Grazing (% of Total)		Distribution of All Activities Combined (% of Total)	
	Deer	Elk	Deer	Elk	Deer	Elk
Aspen	61.9	36.5	43.3	18.3	57.5	23.5
Clearcut	0.0	0.9	4.8	8.4	2.7	1.0
Conifer	3.6	10.4	0.0	0.0	0.1	5.3
Meadow	20.9	47.8	37.5	61.8	31.3	63.5
Mountain Brush	13.7	4.3	14.4	8.9	6.9	4.5
Logging Road	0.0	0.0	0.0	2.6	1.3	2.0

CONCLUSIONS

Meadow bottoms are an important food supply for both deer and elk using the aspen type, yet they are a relatively fixed resource. As such, they should be protected through planning which restricts logging of aspen clones in and peripheral to them. Likewise, roads and campgrounds should not be located on or adjacent to meadows, if possible.

Julander and Jeffery (1964) suggest that most aspen summer range in Utah would provide increased big game values through management practices which would open the forest canopy and promote understory growth. However, Pengelley (1972) cautions that benefits demonstrated to result from overstory removal in one ecological setting do not necessarily accrue in other situations, and suggests that, in the past, these benefits have most often been obtained accidentally rather than through planned vegetative manipulation.

Clearcutting in the Chicken Creek watersheds obviously has not improved big game values in the present ecological setting. However, livestock grazing and/or increased human activity would likely push big game out of the bottoms, thereby, increasing the value of improved forage production in clearcuts. Likewise, increased big game numbers (1977 populations were relatively low) would soon deplete the forage supplies in bottoms and place increased pressure on secondary feeding sites.

Closure of old logging roads and unnecessary off-road vehicle trails would not only serve to decrease interference with big game activity, but also provide preferred forage resources and lanes of travel for big game in some areas.

Microclimatic conditions appear to strongly affect animal preferences for feeding and resting sites, although the exact nature of the relationship is not clearly understood. Further investigation of microclimatic effects on big game distribution would probably produce information valuable in the planning of habitat conversions or improvements in the aspen type.

LITERATURE CITED

Altmann, J. 1974. Observational study of behavior: sampling methods. Behavior 47:227-265.

Arnold, G. W. 1969. Regulation of food intake in grazing ruminants, p. 264-275. In: A. T. Phillipson (ed.). Physiology of digestion in the ruminant. Oriel Press, New Castle Upon Tyne, England. 636 p.

Black, H., R. J. Scherzinger, and J. W. Thomas. 1976. Relationships of Rocky Mountain elk and Rocky Mountain mule deer habitat to timber management in the Blue Mountains of Oregon and Washington, p. 11-31. In: Elk-logging-roads symposium. University of Idaho.

Brown, E. R. 1961. The black-tailed deer of western Washington. Wash. State Game Dept. Biol. Bull. 13, 124 p.

Buechner, H. K. 1950. Life history, ecology, and range use of the pronghorn antelope in Trans-Pecos, Texas. Amer. Midland Natur. 43(2):257-254.

Collins, William B. 1977. Diet composition and activities of elk on different habitat segments in the lodgepole pine type, Uinta Mountains, Utah. M.S. thesis, Utah State University, Logan. 82 p.

Deschamp, Joseph A. 1977. Forage preferences of mule deer in the lodgepole pine eocsystem, Ashley National Forest, Utah. M.S. thesis, Utah State University, Logan. 86 p.

Edgerton, P. J., and B. R. McConnell. 1976. Diurnal temperature regimes of logged and unlogged mixed conifer stands on elk summer range. U.S.D.A. For. Serv. Pac. N. W. For. & Range Exp. Sta. Note PNW-277, 6 p.

Johnston, R. S., and R. D. Doty. 1972. Description and hydrologic analysis of two small watersheds in Utah's Wasatch Mountains. USDA For. Serv. Int. Mtn. For. and Range Exp. Stn. Res. Paper INT-127, 53 p.

Julander, O., and D. E. Jeffery. 1964. Deer, elk, and cattle range relations on summer range in Utah. Trans. N. Amer. Wildl. Conf. 29:404-414.

Longhurst, W. M., H. K. Oh, M. B. Jones, and R. E. Kemper. 1968. A basis for the palatability of deer forage plants. N. Amer. Wildl. Conf. Proc. 33:181-192.

Lonner, T. N. 1976. Elk use-habitat type relationships on summer and fall range in Long Tom Creek, southwestern Montana, p. 101-109. In: Elk-logging-roads symposium. University of Idaho.

McMahan, C. A. 1961. Food habit study of livestock and deer. Tex. Game and Fish Comm., Federal Aid Proj. W-76-R-4, Job 8, 156 p.

Neff, D. J. 1974. Forage preferences of trained mule deer on the Beaver Creek watersheds. Ariz. Game and Fish Dept. Spec. Rep. 4, 61 p.

Pederson, R. J. 1976. Pre-logging elk habitat use, p. 85-87. In: Elk-logging-roads symposium. University of Idaho.

Pengelley, W. L. 1972. Clearcutting: detrimental aspects for wildlife resources. J. Soil and Water Conserv. 27(6):255-258.

Smith, Michael A. 1976. Feeding behavior of pen reared mule deer under winter range conditions. Ph.D. dissertation, Utah State University, Logan. 85 p.

Wallmo, O. C. 1951. Fort Huachuca wildlife area investigations. Ariz. Game and Fish Dept. Federal Aid Proj. W-46-R-1, Job 3, 100 p.

Wallmo, O. C., and D. J. Neff. 1970. Direct observations of tamed deer to measure their consumption of natural forage, p. 105-110. In: Range and wildlife habitat evaluation--a research symposium. U.S.D.A. For. Serv. Misc. Publ. 1147.